## **CLAIMS**

## What is claimed is:

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1. A microcapsule comprising one or more internal, immissible liquid phases enclosed within a polymer outer membrane having a melting temperature, and further comprising one or more energy absorbing components in an internal liquid phase in

contact with the outer membrane, wherein the energy absorbing component has a higher

specific absorption rate for magnetic, radiofrequency, microwave, or ultrasound than the

specific absorption rate of the polymer membrane.

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2. The microcapsule of claim 1, wherein the energy absorbing component is a magnetic particle and the energy is a magnetic field.

1 3. The microcapsule of claim 1, wherein the energy absorbing med

orbing medium comprises

amorphous carbon, graphite, aluminum powder, acetylene black, TWEEN, sodium amyl

alcohol, or paraffin oil, and the energy is radiofrequency or microwave.

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4. The microcapsule of claim 1, wherein the energy absorbing medium comprises a

spheroid within the microcapsule, and wherein the spheroid contains amyl alcohol,

sorbitan monooleate, SMO-20, graphite/oil, or an oil/and wherein the energy is

4 ultrasound.

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5. The microcapsule of claim 1, wherein the microcapsule comprises at least one

internal aqueous phase and at least internal hydrocarbon phase.

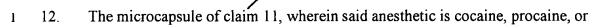
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- 1 6. The microcapsule of claim 1, wherein said outer polymer shell comprises glycerol
- 2 monosterate, glycerol monooleate, glycerol monolaurate, glycerol dioleate, glycerol
- distearate, cholesterol, stigmasterol, phytosterol, campesterol, lecithins, polyvinyl
- 4 pyrrolidone, polyvinyl alcohols, hydrocolloids, polyethylene glycol 400-20000 daltons,
- dextran 1000-100000 daltons, polyvinylpyrrolidone, polyvinyl alcohols or combinations
- 6 thereof.
- 1 7. The microcapsule of claim 1, wherein one of the internal liquid phases contains a
- 2 drug or drug precursor.
- 1 8. The microcapsule of claim 1, wherein a first internal liquid phase contains a drug
- 2 precursor, and a second internal liquid phase immiscible with the first internal liquid
- 3 phase contains an activator of the drug precursor.
  - 9. The microcapsule of claim 7, wherein said drug or drug precursor is an anti-cancer drug or anti-cancer drug precursor.
- 1 10. The microcapsule of claim 9, wherein said anti-cancer drug is cis-platin,
- doxorubicin, daunorubicin, diaziquone, paclitaxel, aziridinylbenzoquinone, muramyl-
- 3 tripeptide, 5-fluorouracil, cyclophosphamide, melphalan, dacarbazine, methotrexate,
- 4 cytarabine, azaribine, mercaptopurine, thioguanine, vinblastine, vincristine, bleomycin,
- 5 prednisone, ethinyl estradiol, diethylstilbestrol, tamoxifen, testosterone propionate, or
- 6 fluoxymesterone.

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11. The microcapsule of claim 7, wherein said drug or drug precursor is an anesthetic.



2 lidocaine.



13. The microcapsule of claim 7, wherein said drug or drug precursor is a systemic antibiotic.

1 14. The microcapsule of claim 13, wherein said antibiotic is a penicillin, vancomycin,

a cephalosporin, erythromycin, ampicillin, amoxicillin, chloramphenicol, rifampicin,

3 gentamicin, sulfanilamide, sulfadiazine, sulfamethoxazole, sulfisoxazole, sulfacetamide,

4 para-aminobenzoic acid, streptomycin, or isoniazid.

1 15. The microcapsule of claim 7, wherein said drug or drug precursor is a systemic

2 antifungal.

1 16. The microcapsule of claim 15, wherein said antifungal is nystatin, or

2 amphotericin B, or griseofulvin.

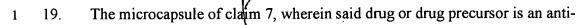


17. The microcapsule of claim 7, wherein said drug or drug precursor is a systemic

2 antiviral.

1 18. The microcapsule of claim 17, wherein said antiviral is idoxuridine,

2 iododeoxuridine, riboviran, or amantidine.



- 2 parasitic.
- 1 20. The microcapsule of claim 7 wherein said drug or drug precursor is an anti-
- 2 inflammatory.
- 1 21. The microcapsule of claim 7, wherein the drug or drug precursor is a hormone, a
- steroid, hydrocortisone, dexamethasone, alsystemic quinolone, an aminoglycoside, an
- antidote, an anti-cholinesterase, a metal polyoning antidote, a cytotoxic agent, an
- 4 immunomodulator, a cytokine, an interleukin, an alpha-antitrypsin, a bone metabolism
- 5 regulator, a hypercalcemic agent, a cardiovascular agent, a beta blocker, a cerebral
- 6 vasodilator, a cerebral metabolic enhancer, a colony stimulating factor, a granulocyte-
- 7 colony stimulating factor, a granulocyte macrophage-colony stimulating factor, a
- 8 vasopressor, a local diabetic agent, a CT scan enhancer, an angiocardiography agent, an
- 9 adenosine deaminase deficiency agent, a gonadotropin inhibitor, an adrenal cortical
- steroid inhibitor, a gonadotropin releasing hormone stimulant, a urofollitropin, a muscle
- relaxant, a neuromuscular blocking agent, a prostaglandin analog, a prostaglandin, a
- prostaglandin inhibitor, a respiratory therapy agent, an anticholinergic, a beta andrenergic
- stimulator, metoclopramide, tetrahydrocannabinol or a sympathomimetic.
- 1 22. The microcapsule of claim 7, wherein said drug or drug precursor is a
- 2 thrombolytic agent.
- 1 23. The microcapsule of claim 22, wherein said thrombolytic agent is urokinase
- 2 (uPA), tissue plasminogen activator (tPA) or streptokinase.

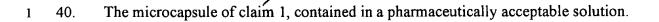


- 2 iron, nickel and zinc.
- 1 25. The microcapsule of claim 2, wherein the magnetic particles comprise about 66
- 2 wt % Fe<sub>2</sub>O<sub>3</sub>, about 9 wt % NiO, and about 25 wt % ZnO.



- 1 26. The microcapsule of claim 2, wherein the magnetic particles comprise Fe<sub>3</sub>O<sub>4</sub>,
- 2 oxides of copper, gold, silver or combinations thereof.
- 1 27. The microcapsule of claim 2, wherein the magnetic particles comprise a ceramic
- 2 coating.
- 1 28. The microcapsule of claim 2, wherein the magnetic particles comprise a
- 2 methacrylate, alginate, dextran, polyacrylate, or polyvinyl pyrrolidone coating.
- 1 29. The microcapsule of claim 2, wherein the magnetic particles have a Curie
- temperature of from about 41°C to about 95°C.
- 1 30. The microcapsule of claim 1, wherein the microcapsule has a diameter of from
- about 1 to about 500 microns.
- 1 31. The microcapsule of claim 1, wherein the microcapsule has a diameter of from
- 2 about 300 to about 500 microns.

- 1 32. The microcapsule of claim 1, wherein the microcapsule has a diameter of from
- 2 about 50 to about 300 microns.
- 1 33. The microcapsule of claim 1, wherein the microcapsule has a diameter of from
- 2 about 30 to about 50 microns.
- 1 34. The microcapsule of claim 1, wherein the microcapsule has a diameter of from
- 2 about 20 to about 30 microns.
- 1 35. The microcapsule of claim 1, wherein the microcapsule has a diameter of from
- 2 about 1 to about 20 microns.
- 1 36. The microcapsule of claim 1, wherein the microcapsule is further defined as
- 2 containing a radiocontrast media.
- 1 37. The microcapsule of claim 34, wherein the radiocontrast media is a halogenated
- 2 oil.
- 1 38. The microcapsule of claim 37 wherein the radiocontrast media is halogenated
- 2 poppy seed oil, cotton seed oil, soybean oil, safflower oil, corn oil, sunflower seed oil,
- 3 sesame seed oil, or canola oil.
- 1 39. The microcapsule of claim 37, wherein the radiocontrast media is iodinated poppy
- 2 seed oil.



41. A composition comprising microcapsules, and wherein said microcapsules comprise two or more internal, immiscible liquid phases enclosed within a polymer outer membrane having amelting temperature, and further comprising one or more magnetic particles in an internal liquid phase in contact with the outer membrane, wherein the magnetic particles have a Carie point higher than the melting temperature of the polymer membrane; and further wherein a first portion of said microcapsules contain magnetic particles with a first Curie point, and a second portion of said microcapsules contain

magnetic particles with a second Curie point, and further wherein the first Curie point is

- 42. The composition of claim 41, wherein the microcapsules contain a drug.
- 43. The composition of claim 42 wherein said first portion contains a different drug than said second portion.
  - 44. A method of controlling the release of a drug comprising:

different than said second Curie point.

providing a drug delivery solution comprising microcapsules comprising one or more internal, immiscible liquid phases enclosed within a polymer outer membrane having a melting temperature, and further comprising one or more energy absorbing components in an internal liquid phase in contact with the outer membrane, wherein the energy absorbing component has a higher specific absorption rate for magnetic,



radiofrequency, microwave, or ultrasound than the specific absorption rate of the polymer membrane, and a drug contained in at least one of the internal liquid phases;

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administering the drug delivery solution to a subject; and

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- exposing the microcapsule to an energy source, effective to heat the internal component and to melt at least a portion of the polymer outer membrane and to release the drug.
- 1 45. The method of claim 44, wherein the energy absorbing component is a magnetic particle and the energy is a magnetic field.
- The method of claim 44, wherein the energy absorbing medium comprises amorphous carbon, graphite, aluminum powder, acetylene black, TWEEN, sodium amyl alcohol, or paraffin oil, and the energy is radiofrequency or microwave.
- The method of claim 44, wherein the energy absorbing medium comprises a spheroid within the microcapsule, and wherein the spheroid contains amyl alcohol, sorbitan monooleate, SMO-20, graphite/oil, or an oil, and wherein the energy is ultrasound.
- 1 48. The method of claim 45, wherein the magnetic particles comprise a mixture of
  2 oxides of iron, nickel and zinc, and further comprise a ceramic coating.
  - The method of claim 45, wherein the electromagnetic field is an electromagnetic field with a frequency of from about 20 to about 500 KHz.

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- 50. The method of claim 45, where n the electromagnetic field is an electromagnetic
- 2 field with a frequency of from about 85 to about 100 KHz.
- 1 51. The method of claim 44, wherein the microcapsules contain a drug precursor in a
- 2 first internal liquid phase and an activator of the drug precursor in a second internal liquid
- phase immiscible with the first internal liquid phase and the method further comprises
- 4 exposing the microcapsules to an energy sourde effective to mix the immiscible internal
- 5 liquid phases and increase the kinetics of activation of the drug precursor prior to heating
- 6 the magnetic particles.
- 1 52. The method of claim 51, wherein the energy source is UV light of 220-390
- 2 nanometers.
- 1 53. The method of claim 44, wherein the microcapsules also contain a radiocontrast
- 2 medium.
- 1 54. The method of claim 53, wherein the radiocontrast media is halogenated poppy
- 2 seed oil, cotton seed oil, soybean oil, safflower oil, corn oil, sunflower oil, sesame seed
- 3 oil, or canola oil.



- 55. The method of claim 54, wherein the microcapsules are administered to a subject
- and detected at a target site by radiography, prior to heating the internal component.

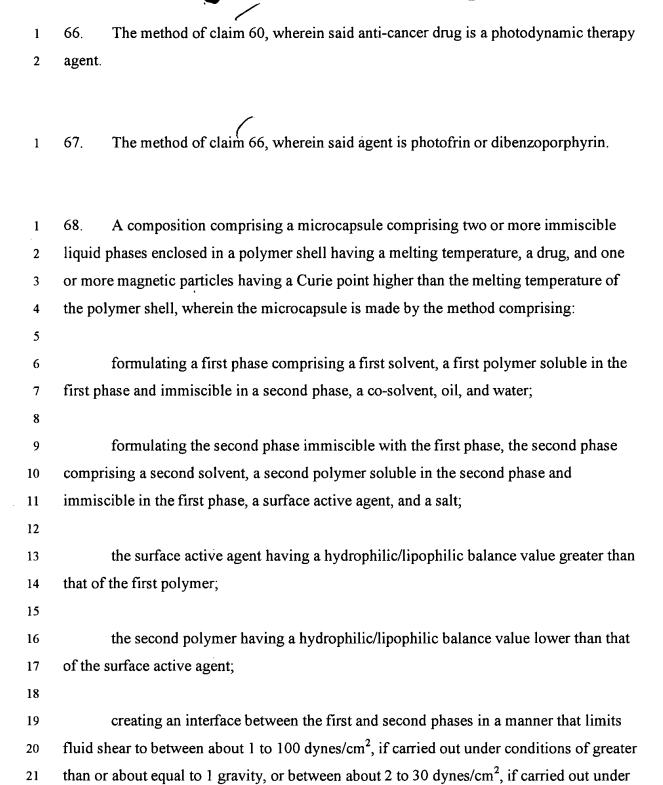
1	56.	The method of claim 44, wherein the microcapsules are administered to a subject
2	intraarterially, intravenously, intraperitoneally, directly into a tissue, or directly into a	
3	tumo	r.
	57	The method of claim 56, wherein the subject is a human.
1	57.	The method of claim 36, wherein the subject is a numan.
1	58.	The method of claim 44, wherein the drug delivery solution contains two portions
2	of microcapsules wherein a first portion of the microcapsules have a different specific	
3	absor	ption rate for the energy source than a second portion.
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1	<b>5</b> 9.	The method of claim 58, wherein the first portion and the second portion contain
2	diffe	rent drugs.
		•
1	60.	A method of treating a tumor in a subject comprising:
2		
3		obtaining a pharmaceutical composition comprising a plurality of microcapsules
4	in a p	harmaceutically acceptable solution, each microcapsule comprising:
5		
6		one or more immiscible internal liquid phases enclosed in a polymer shell
7	havin	g a melting temperature;
8		
9		a magnetic particle contained in an internal liquid phase in contact with
10	the polymer shell and having a Curie point higher than the melting temperature of the	
1	polymer shell and;	
12		
13		an anti-cancer drug contained in an internal liquid phase;
14		

15	administering the pharmaceutical composition to the subject in a manner effective	
16	to place the microcapsules within or adjacent the tumor; and	
17		
18	applying a magnetic field to the microcapsules effective to heat the magnetic	
19	particles to a temperature higher than the melting temperature of the polymer shell,	
20	thereby melting at least a portion of the polymer shell and releasing the drug.	
1	61. The method of claim 60, wherein the pharmaceutical composition is infused into	
2	an artery upstream of the tumor.	

- 1 62. The method of claim 60, wherein the microcapsules also contain a radiocontrast
- 2 agent and the microcapsules are visualized prior to application of the magnetic field.
- 1 63. The method of claim 62 wherein the radiocontrast agent is a halogenated oil.
- 1 64. The method of claim 60, wherein said method is practiced in conjunction with
- 2 hyperthermia therapy.
- 1 65. The method of claim 60, wherein said anti-cancer drug is cis-platin, doxorubicin,
- daunorubicin, diaziquone, paclitaxel, aziridinylbenzoquinone, muramyltripeptide, 5-
- 3 fluorouracil, cyclophosphamide, melphalan, dacarbazine, methotrexate, cytarabine,
- 4 azaribine, mercaptopurine, thioguanine, vinblastine, vincristine, bleomycin, prednisone,
- 5 ethinyl estradiol, diethylstilbestrol, tamoxifen, testosterone propionate, or
- 6 fluoxymesterone.

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characteristics at the interface.



conditions of less than or about equal to 1 x 10<sup>-2</sup> gravity, and maintains adsorptive surface



- 69. A composition comprising microcapsules, wherein said microcapsules comprise one or more internal liquid phases enclosed within a polymer outer membrane having a melting temperature, and further comprising one or more magnetic particles in an internal liquid phase in contact with the outer membrane; and further wherein a first portion of said microcapsules has a polymer outer membrane with a different melting point than a second portion of said microcapsules, and further wherein both the first and second melting points are lower than the Curie point of the magnetic particles.
- 1 70. The composition of claim 69, wherein said microcapsules contain a drug in a least one of said internal liquid phases.
  - 71. The composition of claim 70, wherein said first portion of microcapsules contains a different drug than said second portion of microcapsules.

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